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making and using WOOD FUEL

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The "burning" question, "How shall I heat my home?" is one that poses itself to every New York State farmer at least once in his lifetime. If you are faced with the problem now, probably you are thinking of economy and convenience. Commercial concerns that vend fuels continually present arguments for both coal and oil. Glance at the possibility of wood for fuel, and then make a decision for yourself.

Advantages and Disadvantages of Wood Fuel

If you do not own a woodlot

During times of relative prosperity, the purchase of wood for heating your home is a questionable practice. If, however, the ready-to-burn cost of a standard cord[1] of good hardwood is less than that for a ton of coal or for 200 gallons of fuel oil, then the use of wood is worth consideration. Sometimes wood may be obtained from a neighbor's woodlot for the labor of cutting it, or at a very low stumpage price. When labor commands low wage rates, fuelwood's competitive place is more favorable.

If you own a woodlot

Advantages

Generally heat from wood gives the greatest economy, and often the greatest satisfaction, for the following reasons:

1. The heat value available from a standard cord of several of our hardwood species is equal to 1 ton of good anthracite coal or to 200 gallons of fuel oil (table 1, page 8). Many other woodlot species have values only slightly under that of 1 ton of coal.

2. From your own woodlot you can produce that standard cord in a form ready for the fire for from 6 to 10 hours of labor. Assigning a fair wage rate to this labor, places the cost of that cord much lower than the price for an equivalent amount of coal or oil.

3. Heating units (furnaces and stoves) that burn wood efficiently and recover most of the heat which the wood is capable of producing are now available. Many of these units also have the convenience of thermostatic control and forced-air circulation, if desired.

4. The cost of a good wood-burning unit is lower than that of either a good coal-burning unit or an oil heater.

5. In times of national emergency, coal and oil are likely to be rationed. Wood from the woodlot continues to supply unrationed heat at such a time.

6. A power failure does not affect wood-burning as it does oil heating or stokers.

7. Wood is a clean fuel.

[1] A standard cord is the equivalent of a pile of 4-foot wood stacked 4-foot high and 8-foot in length, occupying a space of 128 cubic feet.

8. Wood is a safe fuel.

9. The ash residue left after burning is much lower than that of coal. A standard cord of hardwood reduces to an ash residue of about 60 pounds. This ash has a value as a fertilizer.

11. Wood is a renewable resource. Coal and oil are not renewable and are, therefore, "expensive" fuels in terms of our national resources. We have only so much coal and so much oil in the country, and every ton or every gallon that is burned is not replaceable. By harvesting the growth, we can cut fuelwood from the same acre of ground, every year, forever.

12. If yours is a typical New York State farm woodlot, it is badly in need of a cutting which thins crowded groups, removes defective trees, and takes out inferior species. If a fuelwood cutting is made wisely, the value of the trees which are left can be increased.

13. Fuelwood may be produced at a very low cash expenditure. What is not spent is as important as what is earned.

Disadvantages

Wood has certain disadvantages as a fuel. You should also be aware of these when you make your decision. Some of the disadvantages are the following:

1. Wood is bulky and heavy in relation to its heat content. This means that provision must be made for a storage space greater than that for coal or oil. Homes in cities and villages with restricted storage space may find it impossible to burn wood alone, unless regular delivery can be assured.

2. For best performance, wood must be dry. Coal or oil do not require seasoning.

3. Low pipe or flue temperatures cause the condensation of creosote with its attendant hazard of chimney fires. The creosote problem (page 6), however, can be largely eliminated by proper burning, a good chimney, and proper installation of the heating unit.

4. Like a coal fire, a wood fire must be stoked though not so often as is commonly believed when wood is burned efficiently.

In considering the advantages and disadvantages of wood, coal, and oil, you should keep in mind the labor situation on the farm. On some farms it is a distinct problem to keep hired help productively employed during a short period of winter or during periods of poor weather. Some persons, by nature, would rather work harder taking care of cows in order to make more money to buy coal or oil. The saving which can be effected by investing labor into providing fuel is, however, considerable, especially when fuel-making can be done during slack work periods.

How Wood Burns

The old technique of admitting air under the fire and letting it flow up through the fuel bed and then directly into the chimney flue certainly was the cause for much of the low efficiency

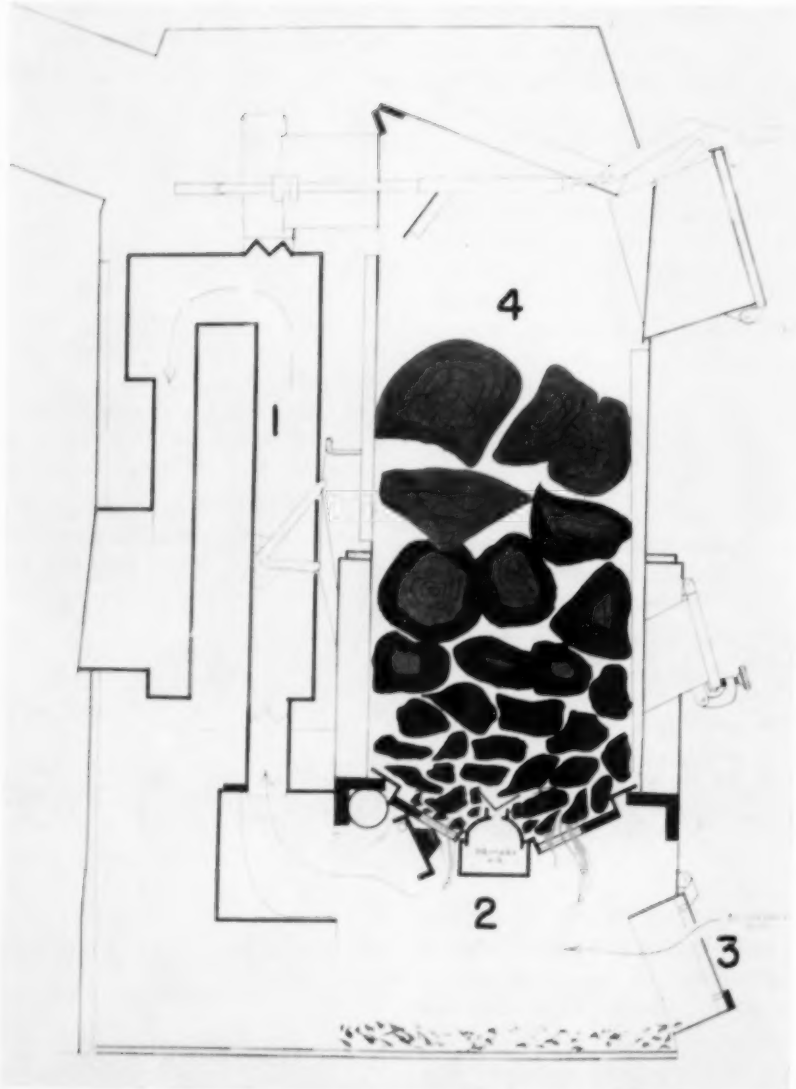

Figure 1. Some principals of efficient wood burning.

1. Long flame path
2. "Upside down" burning. The primary air is admitted right in the fuel bed
3. Provision for secondary air to mix with gases
4. Large storage magazine for fuel. The wood here breaks down into charcoal, the gases are burned and finally the charcoal is consumed

and for many of the problems commonly associated with burning wood. Wood burns quite differently from other fuels, and thus it needs specially designed combustion units to provide satisfactory heat. Consider how wood burns and what it requires to burn with utmost efficiency.

Combustion of wood is preceded by evaporation of the moisture in the wood. Since it requires approximately 1000 B.T.U.[2] per pound of moisture to do this, it is important that the wood be thoroughly seasoned. Then follows the distillation and burning of volatile matter in the wood. Finally, after distillation is complete, the wood has been reduced to charcoal. This charcoal then burns and leaves very little ash residue.

For efficient burning, the combustible gases released during this process need to be mixed with air and burned completely inside the heating unit. Wood burns with a long flame. Most old-type wood units do not make provision for this, but allow these gases to escape up the chimney where their heating value is lost. Then when flue temperatures are below 250°F, fluids which form creosote condense out of these gases. By providing a long flame path (figure 1) the heat from these gases may be recovered and the wood-tar problem reduced.

To attain complete combustion of the wood gases, about 80 per cent of the air needed should be supplied over and around the fuel. The desirability of having air supplied over the fire bed has led to the design of "down-draft" combustion units. Many persons have experienced the more successful performance of wood fired in old-type heating units when air was supplied entirely through the draft control in the upper feed door rather than through the ashpit door. This is an indication of the desirability of the down-draft principle.

When provision is made for a long flame path, when preheated air is supplied by "downdraft," and when dry wood is used, then recovery of the possible 8600 B.T.U. per pound is very high.

New Combustion Units

Combustion units designed expressly to burn wood are available from several sources. These furnaces and space heaters incorporate some or all of the features necessary to burn wood efficiently. Because of the large fuel capacity and controlled burning, most of these units require stoking no oftener than once every 10 hours and sometimes as few as once every 24 hours. Some of these units have a storage magazine like a hopper, which holds a large charge of wood and feeds it slowly into the combustion zone. Others have extremely large fireboxes. These not only permit the stoking of large quantity of wood, but permit the use of very large chunks of wood (as large as 13 inches in diameter and 3 feet long). Though burning large chunks is not so efficient

[2] B.T.U. = British Thermal Units—the heat required to raise the temperature of 1 pound of water 1 degree F.

Figure 2. One furnace has a large fire door to take long wood more than 12 inches in diameter which saves much time in working up the wood.

as burning small sticks, the saving in cost of fuel preparation is great.

On most of these new units, draft regulation is automatic and is thermostatically controlled. The central hot-air furnaces may be the pipeless variety or with pipes. They may be used with blowers for forced-air circulation. Provision is made in some units for auxiliary hot-water heating. Balanced, barometric dampers are often used with wood-burning furnaces to regulate the effects of different draft conditions.[4]

The fireplace has also received attention from those interested in producing greater satisfaction from wood. No longer need it be a romantic way to suck cold air into the room and send it, heated, up the chimney. A fireplace, properly installed or modified, can actually heat a room or take the chill from a house in spring and fall. Modern devices re-circulate room air through metal chambers around the fireplace and pass it out to the room or to other parts of the building.

The kitchen range has come in for attention too. Although it has not been appreciably changed as an efficient wood burner, its convenience and appearance has been tremendously improved. The homemaker certainly need have no qualms about the modern appearance of these new ranges.

The poultryman may also benefit from the use of wood-burning brooder stoves now in use on many poultry farms.

More About the Creosote Problem

The brown, ill-smelling liquid, commonly called *creosote,* is the product of incomplete combustion and too low temperatures. This condensate quite rightly is one of the chief deterents to those who would burn wood. It is both unpleasant and dangerous. It is not, however, a necessary evil associated with the use of wood for fuel. There should be few problems with creosote if you fulfill all the following conditions:

1. Make adequate provision for complete wood-gas burning inside the furnace.

2. Use seasoned wood

[4] A list of manufacturers of wood-burning stoves and furnaces may be obtained from the Extension Forester, New York State College of Agriculture, Ithaca, New York.

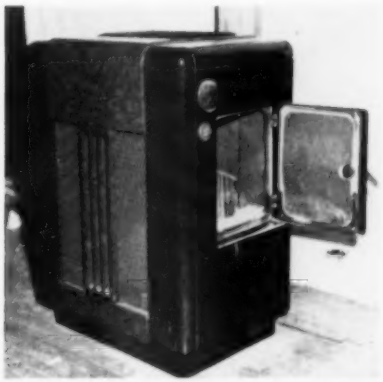

Figure 3. Small space heaters, too, burn wood efficiently. This heater is capable of maintaining fire for nine hours. It is useful as a room heater or a camp heater.

3. Connect the furnace to the chimney with a short length of pipe.

4. Line the chimney with tile.

Outside, unlined, chimneys and long connecting pipes through a cool cellar generally give trouble, for stack temperatures often drop below 250°F. Unless changes are made, wood for fuel will probably be unsatisfactory.

If creosote is a problem, here are some suggestions:

1. Invert the pipes so that the upper pipe fits inside the lower pipe. This generally necessitates a new pipe length at one end or the other.

2. If the connecting pipe path is long, use a double-walled pipe.

3. Reduce pipe path, if possible, by moving heating unit closer to the chimney. Forced-air circulators make it possible to relocate the heating unit.

4. Use a chimney cap to provide better draft and to keep chimney temperature higher.

5. In mild weather, instead of a long low fire, use a short hot one, or several short hot ones.

6. Install a thermostat on the stack which maintains a stack temperature above that at which the wood gases condense. This should be coordinated with the regular thermostat so that they do not conflict.

Seasoning Wood

Green wood will burn, yes, but seasoned wood is lighter, has more heat value, and is less apt to form creosote. Why use green wood when a little planned work will yield a much better fuel?

The greater the surface of wood exposed to the air, the more rapid the

Figure 4. Camps, cabins, and workshops may be adequately heated by heavy cast-iron stoves like the one shown here.

Figure 5. Growth on the managed woodlot yields at least one half a standard cord per acre yearly—forever.

drying. Therefore stack the wood in loose piles that are raised off the ground. Wood greater than 8 inches in diameter or longer than 4 feet dries very slowly. Reduce the size of such sticks by splitting or sawing. Fuelwood should not be stacked in the woodlot for seasoning. Place it in the open to obtain rapid drying and to prevent deterioration. Wood cut during one winter's woods operations and properly piled in the open at that time is thoroughly seasoned by the time the next heating season rolls around.

The Heating Value of Wood

A standard cord of seasoned material of several native New York tree species has the same heating value as 1 ton of hard coal or 200 gallons of fuel oil. The more efficiently you burn this, the more of this total value is recoverable for home heating. In general, the heaviest woods have the greatest heating value. The heating value per air-dry cord of some of our best fuelwoods[1] is given in table 1.

How does this compare with the heating value of other fuels? High-

Table 1. Heating Value of Some Woods

Species	Gross heating value per air-dry cord (B.T.U.)
Rock elm	32,000,000
Shagbark hickory, white oak	30,600,000
Bitternut hickory	29,200,000
Sugar maple	29,000,000
Black oak, burr oak	28,200,000
Beech	27,800,000
Red oak	27,300,000
Yellow birch	26,200,000
Red elm	25,400,000
White ash	25,000,000
White elm (American elm)	24,500,000

grade domestic anthracite has a B.T.U. value of approximately 26,000,000 per ton. Buckwheat anthracite is about 1,000,000 B.T.U. lower than this. Domestic Number 2 fuel oil has a heating value of approximately 140,000 B.T.U. per gallon; in other words 200 gallons have a gross value of 28,000,000 B.T.U.

Which Trees to Cut For Fuelwood

"Cutting trees for fuelwood warms you twice" is an oft-repeated saying of New York woodlot owners. Cutting trees for fuelwood actually can result in double benefits. It can result in both the most economical fuel for heating the home and in a woodlot whose growing potential (and hence value) has been increased.

To obtain the most value, you must cut wisely. Formerly, the owner frequently cut the straight, well-pruned trees for firewood, because they split easier than their crooked, limby breth-

[1] From *Heating Value of Wood Fuel*, by J. D. Hale. Forest Products Laboratories of Canada. 1933.

Figure 6. Such red-maple sprouts are better in the woodpile than in the woodlot.

Figure 7. The Swedish bow saw is useful in pole stands where nothing larger than 10-inch trees are handled.

ren. Such cutting rapidly reduced the woodlot to a junk lot. With timber values what they are today, it is folly to follow such a practice.

Cut only those tress whose removal will give more room for the growth of the best trees in the woodlot. Usually the trees that should be cut are the poorest formed, the poorest pruned, and the lowest dollar value trees in the woods. Hence your fuelwood cutting operation is much like a culling operation in a poultry flock or a dairy herd. With only so much food and space to go around, the poultryman or herdsman removes the least productive or less robust animals and thereby improves the quality of his flock or herd. Woodlot improvement is much the same. Sometimes, of course, fine straight trees must be removed because they are crowding equally good trees, or better ones. This is a higher form of the art of "culling" and requires good judgment.

Woodlot owners who are not familiar with the technique of woodlot improvement may obtain technical advice and service without charge through the New York State Forest Practice Act. A forester from the New York State Conservation Department will formulate a management plan for the woodlot of farmers who cooperate under this Act, and will mark the woodlot for an improvement cutting or timber sale.[8]

Fuelwood Production

It is a cardinal principle that the fewer times the wood is handled the cheaper the cost. To this end many farsighted woodlot owners have laid out a system of woods roads that make it possible to bring equipment close to the tree and to skid saplings and poles of tree length to the roadway. Such roads make it possible to bring in regular tractors and equipment instead of special woods equipment.

The axe and the saw are still common equipment in many fuelwood operations in New York. Far from being crude tools, these are fine pieces of equipment when in the hands of craftsmen familiar with their use. An amazing volume of wood can be pro-

[8] For further information about this service, consult your local District Forester of the New York State Conservation Department, the Extension Forester at the New York State College of Agriculture, or your County Agricultural Agent.

Figure 8. For large cull logs, the drag saw is a useful tool in the wood yard.

duced by a skilled woods worker with only a sharp axe and a properly filed and fitted saw. For trees less than 10 inches in diameter, the relatively new Swedish bow saw is much more efficient than the crosscut saw. Though many farmers have trouble with the saw "running" or cutting an arc, a properly set and filed saw which is not forced or "ridden" will cut both straight and fast. Select axes of high quality to obtain the best service.

A number of power saws have become available in recent years. These saws have evolved from the original drag saws, through circular saws to the chain saw. Recently a new type, the one-man power reciprocating saw, harkening back to the drag principle, was introduced (figure 9). Drag saws still have their place and do a good

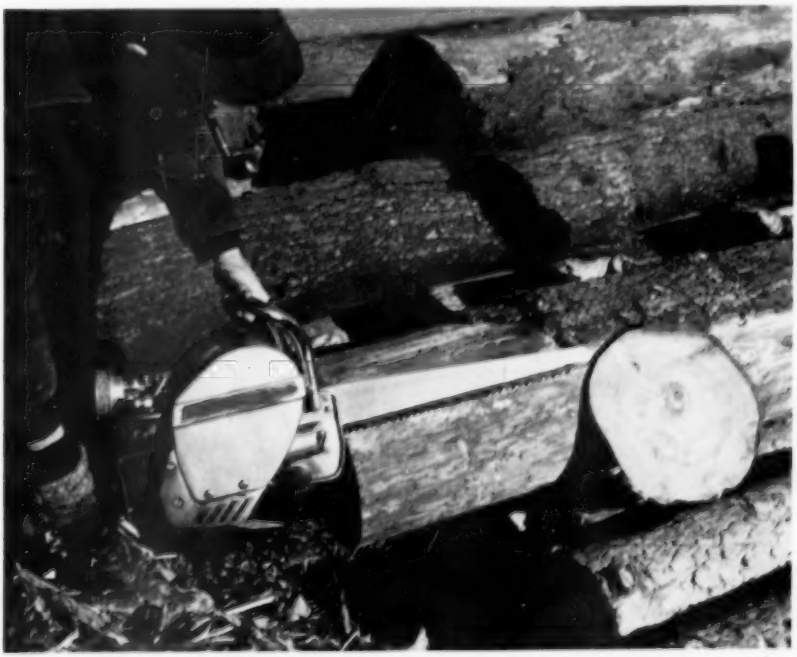

Figure 9. Power saws, both of the chain type or the reciprocating type, are portable, light, reliable tools for woods work.

job of working up large trees once the trees are felled. In most woods, the chain-type power saw, either of the two-man or one-man pattern, is the common tool on New York farms. Good one-man saws are now available that are capable of making cuts up to 20 inches and will double the production of a manual saw and do it at two-thirds or less of the cost. Weight has been reduced to as low as 20 pounds and prices have been brought to a point within reach of most farm woodlot owners. Reliabilty and usefulness have been increased to the point where a buzzing rig is not often used on large material. A power chain saw must be kept running and cutting to be profitable.

Buzz rigs on tractors serve a useful purpose in working up small material, especially where the axe and hand saw have been used for felling. Proper belting, saw speeds, and safety measures must be considered in using these saws. There have been many accidents through the use of improper types of belts, saws, saw speeds, and careless operation.

Figure 10. A buzz rig properly belted and guarded is an efficient tool for making fuelwood.

Aside from conventional hand splitting using wedges or mauls, wood may be split in two ways: (1) in the woods and in lengths up to 12 feet with the splitting gun; (2) in the wood yard in lengths up to 2 feet with a splitting machine. The splitting gun utilizes black powder (never use smokeless powder since it will blow up the gun). Fill the barrel of the gun two-thirds full of powder, wad lightly with paper, turn the firing port to the side, and drive it 2 or 3 inches into *solid* wood in the log to be split. Then prop a chunk against the gun, place a 3-inch slow-burning fuse in the firing port and touch it off and get behind a tree. The logs, even elm, split into thirds or quarters for easy handling. Some of the homemade splitting machines are similar to the type shown in figure 12 and are usually powered by an electric motor. Fuelwood up to 24 or 26 inches in length may be handled successfully.

As previously stated wood should be handled as little as possible from the tree to the furnace. Many operators, in polewood stands that need thinning, find that tree-length or long-tree with the butt facing the woods road. Then skid or winch in long stick handling works well. Fell the lengths to the road where your tractor-mounted buzz rig and farm wagon are

Before

After

Figure 11. The splitting gun helps to work up large chunks or butts of elm, maple, and other difficult pieces. *Black powder* is always used.

Figure 12. A vertical wood-splitting machine made on the farm by Carl Jeering, Walworth, New York. This machine will handle chunks up to 24 inches in length.

ready to go into action. Buzz wood to the proper length, throw it directly into the wagon at random, and, when full, haul the load to the wood storage and unload it (dump wagons work well). In rougher areas, a woodshod sled handles bolts consisting of multiples of the fuelwood length. If the wood is 30 inches long, make the bolts 60 or 90 inches long. The sled holds a surprising volume of wood and handles readily in rough going.

In working up the culls and tops of logging operations, you follow slightly different techniques. You may split the "rough" wood with a splitting gun, buzz it up, and load it, or use the chain saw to cut to proper length and then split the wood on the splitting machine. In either method the fewer times the wood is handled the better.

One objection to wood has been the fact that it leaves the woodbin dirty. Much of the "dirt" is made up of bark which sloughs off as the wood is handled. This objection can be overcome to a large extent if you peel the wood before you use it as fuel. Chemi-peeling takes much of the labor out of the job. The chemical, sodium arsenite, is applied to the selected trees by painting it on the exposed sapwood of a bark-peeled girdle. To make the girdle, remove a strip of bark at least 6 inches wide, as low as possible on the tree stem during the sap-peeling season. After a winter has elapsed, the bark is easily removed; in many cases it falls off during the fuelwood cutting without any special effort directed towards removing it. Beech, which is a good fuelwood, responds better than any other species to this chemical debarking. Beech bark sloughs off standing trees (figure 15). This technique is fully described in a leaflet of the Department of Conservation.[6]
Remember that sodium arsenite is poisonous and must be handled with due caution.

[6] *Bark Removal Using Sodium Arsenite*, by Lawrence S. Hamilton. Mimeo. Leaflet 9. Department of Conservation. Cornell University. 1954.

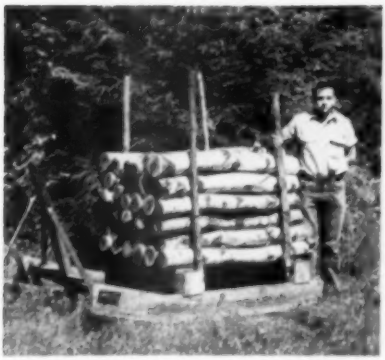

Figure 13. A wood-shod sled is easily loaded, and will carry a large quantity of wood over rough terrain. This one was made by David B. Cook of Albany, New York.

Figure 14. New wood burners take longer wood. The furnace in this farm home uses the culls from the woodlot. Note the forester's marks on the stick. The woodpile should be covered for best heat value.

Figure 15. Chemically peeled beech makes a high-grade, clean fuel. With beech, the bark sloughs off the standing tree.

Chain Saw

Safety Rules

1. Carry the saw by the handles only.
2. Men carrying a two-man saw on steep or slippery ground should walk abreast.
3. When you carry chains to and from a job, roll them up and carry them by a rope or wire, or in a special carrying case, as protection against cuts and damage.
4. Inspect trees carefully for loose limbs, rot, and the like before starting to cut. (You cannot hear a rotten limb crack when the saw is going.)
5. Swamp out around the tree or the log back of the chain so it does not catch on anything.
6. When felling a tree, choose your escape path *in advance*. Be sure that there are no obstructions to slow down your getaway.
7. Wear heavy shoes or boots that have non-skid soles and will not slip. Leather soles are usually dangerous.
8. Leave the chain saw on the ground or on the log while starting the engine. Be sure the saw is solidly placed.
9. When operating a saw, stand at the *ends* of the saw, NEVER to the side.
10. Keep a firm grip on the handles and keep the guard or dog tight against the tree or log. Brace your body against the engine handles so that if the saw pinches, you will be *pushed* rather than *struck*.
11. Shut off the engine except when the saw is actually in use. This prevents damage both to you and to the chain.
12. Stop the chain before wedging. If the wedge touches the moving chain, it will break the teeth or cause the saw to kick back if it does not stall.
13. Use wood or magnesium wedges. They are light and do not seriously damage the chain.

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